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著者	Terauchi Masanori, Iino Atsushi
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Masanori TERAUCHI

Introduction

The architectures and mechanisms underlying sentence processing are also required as one of the most important parts of those underlying human language processing. Sentence processing, which is composed of various aspects of subordinated cognitive activities and behaviors, occurs principally on the basis of cognitive architecture, mechanisms and processes at different levels and stages. In addition, research into sentence processing has been a central focus and major concern in psycholinguistics, computational linguistics, artificial intelligence, and neurolinguistics (Clifton, Frazier, & Rayner, 1994; Pickering, Clifton, & Crocker, 2000; Harrington, 2001). Significantly enough, sentence processing research is completely different from research into language structure and function, in that it is principally concerned with illuminating and elucidating cognitive architectures, mechanisms, and processes responsible for language as a dynamic, real time entity (Harrington, 2001:91). One of the major concerns of sentence level processing is how the two major different sources of linguistic and extralinguistic information function, in an interactive and compensatory manner in real time, to construct a particular and valid syntactic analysis for a string of words or sentence fragments, and assign it a semantic interpretation with a view to yielding the most appropriate meaning of a sentence, or sentences.

It follows from the reasons above that it is significant and necessary to illuminate and elucidate the architectures, mechanisms of sentence processing in the context of cognition in general and in connection with cognitive science as a whole (Pickering, 1999; Pickering, Clifton, and Crocker, 2000, 1-2).

In addition, as has been examined above, it is extremely difficult and next to impossible

to investigate and illuminate the general nature of the cognitive mechanisms responsible for sentence level processing by adopting a single particular research method. Therefore, it is essential to make an appropriate and plausible attempt to adopt more than one effective and efficient research method. At the same time, or in parallel in accordance with the proper nature of the target research theme, We have to seek to combine these methods in order to conduct appropriate experimental research, and to analyze the research findings obtained from research in terms of a theoretical models. The process can apply to such field as generative grammar, lexical functional grammar, formal semantics, psycholinguistics, cognitive neuroscience, information processing, and so on.

The principal aim of the present research is to investigate the following three major issues

1. To elucidate what syntactic processing strategies Japanese EFL learners are inclined to adopt in the natural course of sentence processing.
2. To examine whether Japanese EFL learners follow syntactic processing principles when they encounter syntactically and semantically ambiguous sentences.
3. To explicate how Japanese EFL learners' sentence processing strategies function in the case of resolving syntactic and semantic ambiguity elicited mainly by garden-path sentences

1 Research Questions and Hypotheses

The following hypotheses were formed principally on the basis of the theoretical premises and preceding findings regarding L2 processing research.

Foot Note:

Explicit details of previous studies have been omitted in this research paper mainly due to limitations on article length. If further information is needed, See Terauchi (2003a), Terauchi (2003b), Terauchi (2004a), Terauchi (2004b), Terauchi (2004c), Terauchi, et al (2004).

This paper has been revised and elaborated by adding subsequent research findings including more experimental data to Terauchi (2004a), (2004b).

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Research question 1: What sort of processing has the priority in the sentence-level processing?

Hypothesis 1.1 In a single sentence level condition, the priority is, in principle, given to syntactic processing over semantic processing particularly in the initial parsing decision.

Hypothesis 1.2 The subjects who put a priority on syntactic processing are inclined to process, and/or interpret the sentences which are difficult to parse, or the garden path sentences, more accurately and appropriately than the subjects who put a priority on semantic processing.

1.1 The theoretical premise for making hypothesis 1.1 and 1.2

Both hypothesis 1.1 and 1.2 are formed specifically on the foundation of a syntax-based account. In the syntax-based account, the comprehension process can be generally regarded as ‘the application of autonomous syntactic principles’ (Juffs and Harrington, 1995, 1996; Juffs, 1998a, 1998b, Pickering, 1999, Pickering, et al, 2002; Harrington, 2001, Harrington, 2002). Furthermore, “these principles serves as the exclusive basis for initial parsing decisions, which are subsequently fed to interpretative processes that evaluate and, if necessary, revise the initial parse (Pritchett, 1992). Semantics, frequency, and contextual information are assumed to play no role in initial parsing decisions.” (Harrington, 2002, 125).

Research question 2: What kind of processing strategies are adopted for syntactic analysis of a sentence?

Hypothesis 2. The subjects who adopted parallel-distributed processing during syntactic processing have a higher possibility of reaching an accurate syntactic processing, or comprehension, than the subjects who adopted serial processing.

1.2 The theoretical premise for making hypothesis 2

Hypothesis 2 is formed mainly on the basis of a parallel-distributed processing account.

In the parallel-distributed processing account, a sentence processor is assumed to compute and consider more than a single particular syntactic analysis at the same time, or in parallel, immediately after it encounters a syntactically and semantically ambiguous sentence such as a garden-path sentence.

That is, specifically, in the present study; experiment 1, more care should be taken with the meaning of the technical term, ‘parallel-distributed processing.’ It means the syntactic processing which is performed with consideration of the possibility of using alternative syntactic processing strategies and/or alternative interpretation at a time, or in parallel, without using only one specific syntactic processing strategy and/or interpretation in the analysis of a garden-path sentence, or a sentence which is difficult to syntactically parse. Furthermore, the integrate, or proficient readers who were able to adopt a parallel-distributed processing were supposed to have a higher possibility of achieving accurate and appropriate syntactic analysis, and/or interpretation than the non-integrate reader, or non-proficient readers who attempted a serial processing, and in addition to that, the former type of readers are assumed to have a higher possibility of reaching appropriate and correct ambiguity resolution (Block, 1986, 1992).

Research question 3: Where do the readers start rereading a sentence in the case of performing reanalysis of a garden path sentence, or a sentence which is difficult to syntactically parse?

Hypothesis 3. The reader who can return selectively to the target part in reanalysis processing are inclined to reach an accurate and appropriate syntactic processing, and/or comprehension.

1.3 The theoretical premise for making hypothesis 3

Hypothesis 3 is formed principally on the basis of the information-paced parsing hypothesis claimed by Inoue & Fodor (1995) and Fodor & Inoue (1998). The success in syntactic processing and/or interpretation mainly depends on whether the reader is able to select the target part to be reanalyzed through the initial syntactic analysis of a sentence. The

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target part, or point spotted in the initial parsing decision, plays a significant role of ‘mental index’ for attempting the efficient and effective reanalysis of syntactically and/or semantically ambiguous sentence. For example, in a sentence like (1):

(1) I told the boy [the dog bit] [Sue would help him]

If, during the initial syntactic analysis, the proficient reader is inclined to place the ‘mental index’ selectively on the target part, or point of ‘the dog bit’, in the following process of reanalysis, s/he is able to successfully reconstruct a contact clause, or an embedded sentence more easily, in which ‘the boy’ is modified by the target part, or point marked in the initial syntactic processing.

Research question 4: What are the textual factors impeding correct and appropriate syntactic processing, and/or interpretation?

Hypothesis 4. A centrally embedded clause causes more complexity for syntactic processing.

1.4 The theoretical premise for making hypothesis 4

Hypothesis 4 is formed essentially on the significant effect of a sentence structures’ syntactic difficulty and complexity on syntactic processing overload effects.

For example, in the syntactic reanalysis of sentence (1), which has the postpositional modification clause ‘the dog bit’ embedded in the central part of the sentence, it is claimed that integration cost principally caused by syntactic processing overload effects during the reanalysis frequently results in processing breakdown (Pritchett, 1988, 1992; Pickering, 1999; Pickering, et al, 2000; Gibson, 1998, 2000). It is evident that the greater the number of syntactically possible combinations a target sentence has, the higher its syntactic complexity is. Specifically, one of the major reasons for the syntactic processing difficulty and complexity in a center-embedded sentence can be clearly explained by Kimball’s syntactic parsing principle of ‘two sentences’. For example, let us consider the following two sentences

(2) and (3).

(2) [s1 The boy [s2 the girl kissed] slept.]

(3) [s1 The boy [s2 the girl [s3 the man saw] kissed] slept].

Sentences such as (2) which have a second clause embedded in the main clause are relatively easy to syntactically process. However, a sentence such as (3) which has a third clause embedded within the second clause is noticeably more difficult to parse. When readers have to syntactically process two different sentences at a time, or in parallel, they must be able to retain and process these two clauses in their working memory. However, when they have to parse more than two levels of embedding, or the two different sentences at a time, or simultaneously, and the degree of the syntactic complexity increases much more, they become unable to retain and process them. One of the principal reasons for the higher degree of the complexity is closely related to the limited capacity of our working memory (Kimball, 1973, Sakamoto, 1998).

This type of syntactic complexity demands much more cognitive load for a sentence processor. That is because the processor has to compute and consider more than a single possible attachment or association among the strings of words or fragments of a sentence at a time.

2 The Research Method

2.1 Examples of Garden Path Sentences

In order to consider the general nature of a garden path sentence, the following two typical examples are presented. The expected process for each example is briefly described.

(2) Without her contributions failed to come in.

In sentence (2), on the basis of the representative syntactic processing strategy of ‘Late

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Closure', the syntactic parser, or sentence processor, usually does not end its processing procedures of 'Without her', that is, not taking it as a complete phrase. Rather it attempts to include the next word 'contributions' and adopts processing, or/and interpretation of closing a phrase such as 'Without her contribution' as a complete clause. However, when the reader's eyes move on to the word 'failed', the syntactic parser finds no subject in the tentative processing, and/or interpretation it adopted in initial parsing decision.

Reanalysis should be attempted as follows; the parser has to decompose the temporarily packaged phrase 'without her contributions' and then repackage 'without her' as a complete phrase assigning another thematic role to it, and reinterpret 'contributions' as the subject of the main clause. This conscious reanalysis demands a higher cognitive load. That is to say, since this reinterpretation requires conscious reanalysis, it will cost much more.

(3) While the boy scratched the big and hairy dog yawned loudly.

Sentence (3) causes the reader to lead directly to garden path effects. On the other hand, a sentence like (4) below does not require much more complexity.

(4) While the boy scratched the dog the girl yawned loudly.

According to Ferreira & Henderson (1998), in sentence (4), syntactic and semantic ambiguity does not occur principally because the arguments taken by the adjacent verbs are identified with ease. That is to say, regarding sentence (4), the verb 'scratched' in the subordinate clause takes both 'the boy' and 'the dog' as its arguments. The verb 'yawned' in the main clause takes 'the girl' as its argument. Since the thematic processing domain in the main clause and the one in the subordinate clause are independent, syntactic and semantic ambiguity does not occur in the sentence.

On the contrary, as for the sentence (3), both of the verbs 'scratched' and 'yawned' attempt to take 'the big and hairy dog' as their argument each other. Since thematic processing domains overlap between the two verbs, if the syntactic parser adopts the syntactic

analysis, or/and interpretation that ‘the big and hairy dog’ is the object of ‘scratched,’ there would be found a misinterpretation when another verb ‘yawned’ appears. In order to get rid of this syntactic conflict, overlapped thematic processing domains need to be reanalyzed.

2.2 The present study

Subjects: 143 Japanese University students (75 Hosei University, undergraduates majoring in economics; Hosei University undergraduates; 28 majoring in international culture; 8 Hosei University graduate students majoring in English literature and linguistics; 14 Keio University, undergraduates majoring in English literature; 18 Tsurubunka University undergraduates majoring in Education).

2.2.1 Procedure

For each of twelve garden path sentences (appendix A), the subjects were required to use markings to indicate syntactic analysis and then to translate it into Japanese. The marking they were instructed to make were to use brackets [] to indicate the beginning and end of a clause, or to indicate a phrase with parentheses (), or use an arrow to show modifying relationship. After the marking and translation, they were required to reflect on the cognitive processes and procedures of their syntactic analyses and write down as concrete a description as possible in Japanese. At the next stage, the questionnaires about the processing strategy they had adopted during processing were offered to the subjects and they were requested to answer the following three questions: (1) “How did you think about the possibility of syntactic analysis, and/or interpretation ?; (2) What did you do if you found your syntactic analysis, and/or interpretation incorrect ?; (3) Where did you start your reanalysis in the sentence ? (For the choices, see appendix B). For the completion of the processing data-collection tasks, about 180 minutes were given to all the participants in accordance with their self-paced processing.

2.2.2 Data analysis

Translation into Japanese was judged correct or incorrect in a dichotomous scoring protocol, taking into consideration the markings made in the sentence and the Japanese translation as indicators of syntactic and semantic analysis.

The descriptions of how they processed each sentence were also analyzed as significant data to explore what kind of information was principally used. Each subject's degree of reliance on syntactic, semantic or other features in processing the sentences was evaluated by the two researchers. The descriptions difficult to judge were thoroughly discussed between them on a case by case basis.

3. Result and discussion

3.1 Descriptive statistics

(1) Percentage of accurate syntactic analysis, and translation for each sentence

The comprehensibility of each garden path sentence is shown in Figure 1 as the percentage correct in syntactic analysis, and translation based on the 143 students' responses.

Each sentence is presented in Table 1 in the ranked order based on the percentage of accurate responses. Following each sentence, the expected strategy for correct syntactic analysis and interpretation is added.

From Table 1, there is a general tendency that the sentences requiring only 'late closure' had higher correct percentages than the ones requiring 'theta role constraints' and/or 'early closure' as syntactic principle. This tendency might mean the sentences requiring 'late closure' are easier among the garden path sentences than the complicated sentences placed in the bottom half of the table. This argument needs to be thoroughly reconsidered and in addition to that, further subsequent experimental research need to be conducted with a view to elucidating it.

Table 1. Sentences used for experiment, processing expected, and percentage of correct

answers

No.	garden path sentences	Expected processing	%
8	I recognized you and your family would be unhappy here.	LC	88%
2	John knew the children at the day care center were noisy.	LC	77%
3	While the boy scratched the big and hairy dog yawned loudly.	LC	69%
9	The oxygen produced built up in the atmosphere.	LC	51%
5	An old man talked to by Mary came to see her.	LC	43%
7	As the woman edited the magazine amused all the reporters.	LC	42%
4	This was only the beginning of the bad-mouthing robots would receive for the next couple of decades.	LC, re-analysis	38%
12	The pitcher tossed the ball tossed the ball.	EC	39%
6	The criminal confessed his sins harmed too many people.	LC	30%
1	Without her contributions failed to come in.	LC, reanalysis	29%
11	The cotton clothing is made of grows in Mississippi.	LC, [central embedded]	18%
10	I told the boy the dog bit Sue would help him.	LC, [central embedded]	13%

LC; Late closure, EC; Early closure, reanalysis; Theta reanalysis constraints,
Central-embedded; Centrally-embedded sentence

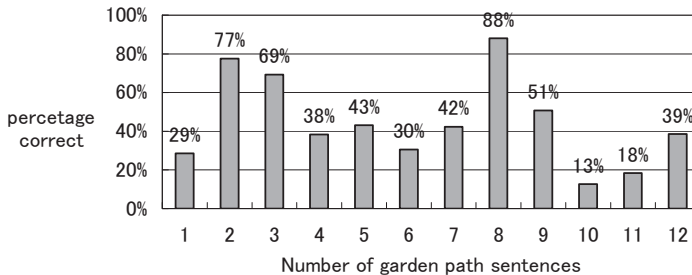


Figure 1. Percentage correct in sentence comprehension

Concerning each sentence, based on required processing for each sentence and the subjects' interlanguage grammar, the results are discussed respectively in the order of the

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sentence with a higher correct percentage.

No.8: “I recognized you and your family would be unhappy here.” (88%), No.2: “John knew the children at the day care center were noisy.” (77%) and No.6: “The criminal confessed his sins harmed too many people.” (30%) are the sentences requiring a reader to recognize the complementizer that guiding the complementary clause omitted right after the predicative verbs. What made the significant difference in difficulty between the sentences with a higher correct percentage such as No.8 and No.2, and the one with a lower correct percentage of No.6 ?

One of the predictable answers was principally based on the (successful) case marking of a noun phrase located in between two verbs; To be more precise, ‘you and your family’ in No.8, ‘the children at the day care center’ in No.2 and ‘his sin’ in No.6. In No.8 and No.2, the verb in each subordinate clause was a ‘be’ verb functioning as the copula, which could not be taken as a postpositional modifier. Therefore, not so many subjects misanalyzed these two sentences; there are only 12% participants misanalyzing sentence (8) by requiring *you and your family as the object of recognized* and only 23% participants misanalyzing sentence (2) by treating *the children at the daycare center* as the object of knew. In terms of case marking in complement sentences, participants would be more frequently inclined to initially misanalyze sentences like (8) by treating the noun phrase *you and your family* as the objects of recognized than sentences like (8a):

(8a) I recognized she and her family would be unhappy here.

This type of misanalysis is not as plausible in (8a), in that she and your family is in the nominative case (Pickering, 1999; 139). In No.6, however, the verb in the subordinate clause is harmed, which can be considered to be either an active past-tense verb or a past participle. Moreover, the word strings of ‘The criminal confessed his sins harmed’ can be understood either S+V [S+V] or S+V+[O+p.p]. In this case, the transitivity of the two verbs of sentence (6) might have confused the readers more than the former two sentences with an intransitive ‘be’ verb. That is to say, one of the predictable reasons for this type of syntactic complexity is closely related to the object/complement (or “NP/S”) ambiguity. For instance,

after a sentence processor encounters the criminal confessed his sins, it initially attempts to view the clause as a syntactically ambiguous one, in that the noun phrase his sins might be the object of confessed or the subjects of a complement clause. In this case, the object analysis demands the postulation of fewer nodes than the complement analysis, therefore, on the basis of the syntactic processing principle such as ‘minimal attachment’, it is adopted in initial parsing decision. However, after harmed is encountered, it becomes quite evident that the object analysis cannot be possible, and/or plausible, therefore, reanalysis is needed in order to achieve the most appropriate syntactic analysis (Pickering, 1999; 33).

These types of syntactic feature information frequently lead directly to a syntactic processing breakdown caused, and/or elicited by the ‘garden path’ effects. In other words, the processor’s cognitive load was heavily challenged to consider which possibility to recognize and to select other parsing possibilities.

In No.3: “While the boy scratched the big and hairy dog yawned loudly.” (69% correct) and No.7: “As the woman edited the magazine amused all the reporters.” (42%), the focal point regarding the syntactic processing of the two clauses was whether the subject in the main clause was required as the object of the verb in the subordinate clause, or not. To be more precise, in No.3 with a rather high correct percentage, one of the most significant parsing problems was whether ‘the big and hairy dog’ was to be interpreted as the object of ‘scratched’ or the subject of ‘yawned’, and also depended on a particular analysis based on one of the principal syntactic processing principle of ‘closure’. That is, in the initial parsing decision, the big and hairy dog is attached as the object of scratched to the sentence structure being currently processed and constructed. After yawned is encountered, there occurs a ‘tug of war’ (Fodor & Inoue, 1998:114). Specifically, there occurs syntactic parsing ambiguity in that the big and hairy dog can be interpreted either as the object of scratched or the subject of yawned. What has to be noticed here is that scratched can be interpreted either as a transitive verb or an intransitive verb, if scratched is required as a transitive verb, syntactic processing breakdown mainly caused by garden-path effects never fail to occur.

In No. 7 with a lower percentage of correct answers, however, it seemed to have elicited a garden path effect over whether to judge the magazine as the object of edited or as the subject of amused. Similar to No.6, one of the possible and predictable explanations for

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the significant difference in percentage correct can be made, depending on familiarity with the content, on lexical preference based on the interlanguage grammar, and/or on syntactic preference which could have interfered with syntactic processing. That is, in the initial parsing decision, the magazine is attached as the object of edited to the sentence structure being currently processed and constructed; According to Late Closure, the parser prefers to adopt the object analysis, or interpretation. Or, it can be suggested that since both edited and the magazine are very likely to belong to the category of the “the work of editing” and are also very familiar. Therefore, the ‘Late closure’ principle may very likely be preferred. However, after amused is encountered, this syntactic analysis turns out to be wrong, and reanalysis is required. Or, in terms of semantic effects, it might have been more difficult for the subjects participating in our research who didn’t have appropriate content schemata to recognize why the relationship between the female editor (the women) and the reporter was described by the verb amused. In other words, if their content schemata failed to be activated appropriately, it would have been difficult for them to achieve the correct syntactic analysis, and/or interpretation.

In No.9: “The oxygen produced built up in the atmosphere.” (51%) and No.5: “An old man talked to by Mary came to see her.” (43%), the first verbs, both ‘produced’ and ‘talked’ respectively, seem to be an active past tense verb in the first pass analysis. There are, however, other verbs following in each sentence. Therefore the reader was expected to interpret which verb functions as a post-modifier attached to a noun phrase or a predicative verb following a subject. In No. 9, the readers might take the part ‘The oxygen produced’ as S+V of the target sentence in the initial parsing decision, however they need to reanalyze the target part when they encounter another verb, ‘built’. That is, they are likely to misunderstand that produced is the matrix verb in the first pass analysis. After they encounter built, however, reanalysis is needed to resolve the syntactic ambiguity, as a result, they interpret correctly and appropriately that produced is the past participle modifying The oxygen and that built is the matrix verb.

The results showed that almost half of the subjects participated in the present study (51%) succeeded in taking ‘produced’ as a postpositional modifier. In other words, however, the rest of the readers failed to interpret correctly, or/and appropriately, seldom imagining that

just one word, ‘produced’, functioned as a postpositional modifier, sandwiched in between the subject and the predicate verb.

Sentence No. 5, with a little lower percentage of correct answers, might have elicited a type of syntactic processing similar to that of sentence No. 9. That is, in the first-pass analysis, readers might have taken the part “An old man talked to” as the S+V of the sentence by treating talked as the matrix verb. However, when they noticed the existence of ‘by’ after ‘to’, and in addition to that, they encountered came, they had to perform a syntactic reanalysis for the target part “talked to by Mary” and as a result, correctly recognized it as the past participle modifying an old man; a postpositional modifier of ‘an old man’ and ‘talked to’ as a phrasal verb in passive voice. Otherwise, only 42% of the readers successfully analyzed, and/or interpreted it. One of the predictable reasons for that might be that there were many subjects who failed to discern the passive voice of a phrasal verb including preposition ‘to.’

No. 12: “The pitcher tossed the ball tossed the ball.” (38%) can be also defined as a typical garden-path sentence (Bever, 1971) requiring the reader to conduct a higher cognitive syntactic analysis for the target part including postpositional modification with a past participle verb. In the case of syntactic processing of this sentence, there is a necessity of performing the syntactic principle of ‘early closure’ which requires the reader to judge ‘tossed’ to be a past participle verb in the initial syntactic analysis. If in terms of a serial processing, when the reader reaches the target part “The pitcher tossed the ball”, s/he might have interpreted it as S+V+O sentence until s/he encounters the second ‘tossed’. And then s/he had to reanalyze the sentence and as a result, recognized that the first ‘tossed’ is a passive voice modifier to ‘the pitcher’ with a view to achieving successful ambiguity resolution. In other words, in the case of parsing of this garden-path sentence, until reaching the ball, the reader interpreted tossed as an active past tense verb. To sum up, if the syntactic principle of ‘early closure’ is applied to the stimulus sentence, the following sentence structure is constructed in the initial syntactic analysis.

(12a) [S [NP The Pitcher] [VP tossed the ball]]

When tossed the ball at the right edge is encountered, the reader realizes that this second

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tossed the ball is the VP of this target sentence. And at the next stage, the reader recognizes that The pitcher tossed the ball is the subject of this sentence, and that tossed is the active past tense form of the transitive verb toss which takes double objects as the subsequent element and modifies The pitcher as the ball does.

From another point of view, the meaning to be reached is closely related to a specific situation in baseball, therefore, it might have been very difficult for some of the readers to draw a proper ‘situation model’ from what the sentence implied. The existence or nonexistence of some sorts of content schemata, or background knowledge about baseball might have been influential as a significant determining factor. That is, one of the possible and predictable reasons for fallacious syntactic analysis, and/or interpretation is that the participants have an insufficient content schemata for baseball.

Other readers seemed to have taken the existence of two ‘tossed’ as emphasis, or an emphatic expression by repetition such as the sentence that the pitcher tossed the ball and tossed the ball. In this way, the cognitive cost of syntactic and semantic processing seemed to spend a more substantial amount of cognitive load and caused a garden path effect.

In No.1: “Without her contributions failed to come in.” (29%), most of the subjects failed to treat the noun ‘contributions’ as the subject of the sentence. They appeared to have the difficulty in breaking apart the phrase ‘her contributions’ elicited principally by the parsing principle of ‘theta reanalysis constraint.’ The cognitive load to consider alternative syntactic analysis, and/or interpretation was so much challenged that, in this case, syntactic processing might have broken down. Therefore, there was a need to change, or revise the first-pass analysis such as “Without her contributions”. However, in that it is conducive to violating theta re-analysis constraints, or the parsing principle of ‘fixed structure’, it might cost more than readers’ meta-cognitive abilities to modify the initial syntactic analysis from “Without her contributions” to “Without her”, i.e. shortening of the governing domain of ‘without’. That is, in No.1, the sentence processor, on the basis of ‘Late Closure’, doesn’t attempt to interpret without her as a complete phrase, and takes in the subsequent noun; contributions and interprets without her contribution as a complete phrase in initial parsing decision. _Nevertheless, when the processor reaches failed, it recognizes that there is no subject of failed, and then attempts to conduct a syntactic reanalysis for the problematic part in order to

find the subject of failed and resolve the syntactic ambiguity. As a result, when the processor attempts to reinterpret theta-assigned structure Without her contributions as without her, and it comes to regard contributions as the subject of the main clause for the purpose of achieving a successful ambiguity resolution. However, in this case, the processor has to consciously attempt to make an appropriate reanalysis for the problematic part with a view to satisfying the well-formedness rule, which can lead directly to “costly.” (Pritchett (1992:15).

Pritchett (1992) tactfully explained the general nature of the above-mentioned syntactic processing ambiguity and complexity by applying the principle based on theta theory to that analysis. For instance, Pritchett (1992) presented the principle of theta assignment and theta reanalysis constraint (TRC) in an attempt to reach a successful ambiguity resolution.

- (a) Theta Reanalysis Constraint (TRC): Syntactic reanalysis which reinterprets a theta-marked constituent as outside of a current theta domain is costly. [Version I]

Here “costly” by definition entails that conscious processing is required, An omission of a middle part of a passage..... Theta domain can be simplistically defined as follows:

- (b) Theta Domain: is in the theta domain of iff receives the theta role from or is dominated by a constituent that receives the theta role from .
(Pritchett, 1992:15).

No. 4: “This was only the beginning of the bad-mouthing robots would receive for the next couple of decades.” (38%), No. 11: “The cotton clothing is made of grows in Mississippi.” (18%), and No. 10: “I told the boy the dog bit Sue would help him.”(13%) can be regarded as the similar types of the garden-path sentences that require the reader to recognize a contact clause embedded in each sentence. In each sentence, since a clause is embedded, the higher cognitive load on syntactic analysis, or syntactic processing overload would have elicited misanalysis in parsing, and/or misinterpretation. Therefore, not many

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of the subjects could reach the most appropriate syntactic analysis, and/or interpretation. It would have caused the processing overload to parse double or triple predicate forms in a sentence, which required the reader to add incoming material to the tentative syntactic structure that was currently being processed.

On the basis of results from the oral interviews with this particular group of subjects, in No.3, one of the possible and predictable reasons for fallacious syntactic analysis of No.3 might be that we found that especially for the most of the Japanese EFL students who participated in the present research, on account of the existence of the subsequent plural nouns ‘robots’, fallacious syntactic analysis was attributable to frequent interpretation of ‘bad mouthing’ as an adjective modifying ‘robots’. So in accordance with Late Closure, they didn’t recognize bad-mouthing as an NP. Instead, they treated bad-mouthing robots as an NP. To put this another way, they are inclined to overlook the fact that the relative pronoun is omitted between bad-mouthing and robots. Or another predictable reason is that Japanese EFL learners are very likely to predict the complement as the subsequent element of was. The following explanation for this type of garden path effect can also be possible, or/and plausible. The subjects attempt to form the NP *the bad-mouthing robots* in the initial parsing decision. Then, they encounter *would receive*, since they have to find the subject, or the external argument of *receive*, reanalysis is required. If they takes the whole NP *the bad-mouthing robots* as the complete subjects, the argument for *of* cannot be found. And then, they need to compute and consider another possibility of syntactic analyses. If they regard the *bad-mouthing and robots* as NP and N respectively, *the bad-mouthing robots would receive* can be interpreted as a reduced relative clause. That is, the *bad-mouthing* can be interpreted as the argument for *of*, and robots for receive, so the syntactic reanalysis is completed.

With regard to this discussion, Pritchett (1988) attempts to argue for the following significant explanation about garden-path effects by focusing specifically on the number and configuration of arguments of a verb.

(13) I convinced her mother hated me. (Pritchett, 1988:570).

As for (13), the following parsing process is performed.

- (a) *I* is identified (as an NP).
- (b) *Convince* is recovered. It assigns one external and two internal roles: <EXT, INT1, INT 2>.
- (c) *Her* is identified and assigned the role INT1.
- (d) *Mother* is identified and the constituent [her mother] NP is assigned the role INT1.
- (e) *Hate* is processed and syntactic reanalysis which moves mother outside the domain of INT1 and into the INT2 domain is required, violating the constraints on Theta Reanalysis and resulting in processing difficulty (Pritchett, 1998:570)

Specifically, in No.11, after *The cotton clothing is made of* is encountered, the following structure can be predicted.

- (11a) [S [NP The cotton clothing] [VP is made [PP of ...]]]

In No.11, most of the subjects who did not conduct the most appropriate syntactic analysis realized that *cotton* and *clothing* had a very close semantic relationship. This has elicited the general tendency for them to interpret *cotton clothing* as NP; a single phrase meaning *clothing made of cotton*. In other words, they had a stronger preference to adopt the syntactic processing principle of ‘Late Closure’. It is not until they reached the end of this stimulus sentence that they recognized that *grows in Mississippi* must be VP of this sentence or that *cotton [clothing is made of]* must be NP guiding the embedded sentence. That is, they were able to recognize that *clothing is made of* is the relative clause working as the embedded clause modifying *The cotton* in the final parsing decision.

In addition to that, Pritchett (1988: 574) deals with a similar example and explains the ambiguity and complexity in syntactic reanalysis as follows:

- (11b) The cotton fields produce makes warm coats.
- (a) *The cotton* is identified as an NP. ...
 - (b) *Fields* is identified as an N. In keeping with Theta-Attachment (‘Every syntactic

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principle tries to satisfy the principle in every phrase of sentence processing'), the NP such as *the cotton fields* is formed.

- (c) *Produce* is recovered and found to assign one external and one internal thematic role. *The cotton fields* is assigned to the external thematic role.
- (d) *Make* is encountered and reanalysis is necessitated. *The cotton* is removed from the EXT domain of *produce* and put into the EXT domain of *make*, as head of the relative clause, violating Theta Reanalysis Constraint (based on Pritchett, 1988: 574).

In No. 11 as well, after *grows* is encountered, it becomes necessary for *the cotton* to assume the external thematic role of *grows* and for *clothing* to assume the internal thematic role of *made of*. This process leads directly to the violation of 'Theta Reanalysis Constraint.'

Specifically, No. 10 was required as the lowest among the sentences with low correct percentages (13%).

- (10) I told the boy the dog bit Sue would help him.

This result is, in principle, in accord with "the syntactic principle of two clauses" (Kimball, 1973 [cited in Pritchett, 1992]). Among the sentences in which the modification clause was embedded in the central part, it can be argued that No.10 was more difficult than No.11 since No.10 contains three clauses whereas No.11 contains two clauses (Pritchett, 1988, 1992; Pickering, 1999; Crocker, 1999; Harrington, 2002; Gibson, 1998; 2000).

That is, No.10 is predicted to compute and consider the following sentence structure until *Sue* is encountered.

- (10a) [S [NP I][VP told] [NP the boy] [S [NP the dog] [VP bit Sue]]]

In the first-pass syntactic analysis, or the initial parsing decision, the sentence processor usually interprets this stimulus sentence as *I told the boy that the dog bit Sue*, and it does not

recognize the syntactic information that the subsequent element *would help him* is VP of the complement sentence of *told* until the end of the sentence. At this point, it realizes that there is no possible NP in the clause other than *Sue* that could be the subjects of the complement sentence. Then the processor *realizes that the object of *bit* is not *Sue* but *the boy* and that *the dog bit* is the relative clause functioning as an embedded sentence modifying *the boy*.

The target stimulus sentence can be defined as one of the typical examples of center-embedded sentence. As to the difficulty, or complexity of syntactic processing, and/or interpretation of center-embedded sentence, Pritchett (1992) refers to the syntactic principle of “Two Sentence” in Kimball (1973). The principle of “Two Sentences” means “the constituents of no more than two sentences can be parsed at the same time” (Kimball, 1973: 33 as cited in Pritchett, 1992: 26). In accord with the syntactic principle of ‘Two Sentences’, in the stimulus sentence, since the processor has to syntactically process three sentences (I told the boy/the dog bit/Sue would help him) simultaneously, or in parallel, the parsing processes becomes more complex and difficult.

Pritchett (1988:574) argues that the parser processes the stimulus sentence as follows:

- (a) *I* is identified as an NP.
- (b) *Tell* is identified as a verb and its theta-girds is recovered. It may assign one external and two internal roles. *I* is assigned the EXT role.
- (c) *The boy* is identified and assigned INT1.
- (d) *The dog* is admitted as an NP and assigned the remaining internal role.
- (e) *Bite* is encountered and theta-gird is recovered. Already at this point, reinterpretation as a relative clause would violate the Theta Reanalysis Constraint, since it would remove the dog from INT2 domain, placing it in the domain of INT1--- precisely the same reanalysis as is forced by *would help him*. (Pritchett, 1988:574).

3.2 Cognitive processes for syntactic analysis, or/and interpretation in each sentence

Table 2 shows the general tendency of the answers to the questionnaire concerning the

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cognitive processes for syntactic analysis, and/or interpretation in each sentence, which was reflectively elicited right after the data-collection task for each stimulus sentence processing is completed.

Table 2 The syntactic processing tendency in every sentence (n=143)

	processing route		Processing timing		Returning position in reanalysis			strategic reliance of information		
	serial	parallel	immediate	Delayed	Beginning	selective	backward	Syntactic	semantic	unclear
Sent.1	77%	23%	44%	56%	59%	31%	9%	70%	16%	14%
Sent.2	62%	38%	36%	64%	53%	32%	15%	81%	11%	8%
Sent.3	61%	39%	38%	62%	56%	32%	12%	76%	13%	11%
Sent.4	61%	39%	33%	67%	49%	34%	17%	65%	10%	25%
Sent.5	61%	39%	39%	61%	56%	31%	13%	66%	14%	21%
Sent.6	70%	30%	38%	62%	54%	36%	10%	72%	11%	17%
Sent.7	59%	41%	35%	65%	58%	32%	10%	67%	17%	16%
Sent.8	69%	31%	35%	65%	50%	43%	7%	75%	11%	14%
Sent.9	54%	46%	42%	58%	57%	36%	6%	65%	13%	22%
Sent.10	57%	43%	38%	62%	56%	35%	8%	71%	11%	18%
Sent.11	65%	35%	37%	63%	58%	31%	11%	61%	18%	21%
Sent.12	52%	48%	32%	68%	59%	28%	12%	57%	10%	33%
average	62%	38%	37%	63%	56%	33%	11%	69%	13%	18%

*Processing route can be mainly divided into either serial processing or parallel-distributed processing.

*Processing timing can be mainly divided into either immediate processing or delayed processing.

*Returning position in reanalysis can be divided into the following three different types of processing in reanalysis; forward reanalysis, selective reanalysis, backward reanalysis

Concerning serial processing and parallel-distributed processing, 62% of all the subjects chose serial processing and 38% chose parallel-distributed processing. As for the distinction between delayed processing and immediate processing, 63% chose delayed-distributed processing, and 37% selected immediate processing.

As for the target position, 56% chose the beginning of a sentence to return to in reanalysis,

processing and 33% chose another point, 11% chose the backtracking. As for processing strategy, 69% put the priority on syntactic information, 18% on semantic information, and 11% on unidentified information. Therefore, as clearly seen in Figure 2, the data can support the view that general tendency of sentence processing was serial, delayed processing with reanalysis from the beginning of a sentence and the reliance mainly on syntactic information.

When seen for every sentence, sentence 8 (88%) which yielded the highest the percentage of correct answers, also had the highest rate of selective positioning reanalysis processing (43%), compared with the other sentences; all the other sentences other than sentence 8 had figures of less than 40% . In addition, the rate of use of the syntactic processing strategy (75%) was also comparatively high. From these results, it can be claimed that the ease of choosing the place to start reanalysis led to the correct answer, or correct syntactic processing and/or interpretation.

In sentence 2 (69% correct answers), the rate of selection of syntactic-based processing strategy was the highest (81%) as compared with the other sentences. Also in sentence 3 (69% correct answers), the rate of selection of syntactic-based processing strategy was as high as 76% (high to the 2nd). It can be safely mentioned that it is conducive to the correct answer to be able to carry out syntactic processing strategy comparatively smoothly beyond the significant influence of semantic effects.

The tendency of sentence 9 (51% correct answers) is that the ratio of parallel-distributed processing is the highest (46%). The ratio of parallel-distributed processing is high to the 2nd, following sentence 12. In syntactic processing of a part in which the two verbs such as '*produced built*' continue, the proficient readers seemed to have processed the target part having more than a single particular syntactic analysis and/or interpretation in a simultaneous manner in their minds.

It is generally acknowledged that parallel distributed processing is considered to be a cognitive process by which the student with a higher level of processing skill exhibits successful syntactic processing. One of the main reasons is that cognitive load on syntactic processing takes much of a working memory resources (Osaka, 2000; Gibson, 2000). Since about half of the subjects answered sentence 9 correctly, it is considered that the sentence is included in the category in which parallel distributed processing succeeded.

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As seen in Table 2, compared with the general tendency as a whole: serial, delayed processing, forward reanalysis, and syntactic information, the numerical value which should be mentioned, is neither observed in sentence 5 (43% correct answers), nor in sentence 7 (42% correct answers). Since the rate of correct answers were less than 50%, it can be said that a processing did not correlate very well with predicted patterns of successful syntactic processing, and/or interpretation.

In sentence 4 (38% correct answers), 49% of the subjects returned to the beginning of the sentence, which was the lowest ratio among all the sentences, but also had the highest rate of backtrack reading, 17%. Since the length of the sentence was the longest of all the stimulus sentences, the results indicated that priority was given to a reanalysis processing strategy of returning backward, without returning to a beginning of a sentence, or that more attention was paid to syntactic analysis, and/or interpretation of the postpositional modification clause located in the second half of a sentence.

Sentence 12 (39% correct) had the highest ratio of parallel-distributed processing (48%) and delayed processing (68%) as compared with the other sentences. On the contrary, the rate of use of syntactic processing indicated the lowest, 57%, but the highest (33%) unidentified use of processing strategy was shown. In this sentence, although the readers carried out syntactic analysis in terms of parallel-distributed processing, considering the possibility of more than a single particular syntactic analysis, and/or interpretation, it is shown that there were a lot of participants who failed to reach the correct answer. It is possible that as a strategy of reanalysis there were many cases where syntax-based processing strategy could not function well enough, compared with the other sentences.

In sentence 6 (30% correct answers), the ratio of serial processing (70%, the 2nd highest) and the ratio of syntactic processing (72%, the 4th highest) were both a little higher than that of other sentences, which means that a higher percentage of correct syntactic analysis, or/and interpretation could have been expected. However, the result was that not so many readers could achieve the proper and appropriate syntactic analysis, and/or interpretation. As the majority of readers reported they had used serial processing and syntax-based processing strategy, the result reflected the situation where many Japanese EFL learners had to carry out syntactic analysis, and/or interpretation principally on the basis of their

incomplete grammatical knowledge, i.e. interlanguage grammar.

In sentence 1 (29% correct), although the rate of selection of serial processing (77%) and immediate processing (44%) was the highest, the percentage of correct answers was rather lower. The approach of immediate processing, and/or interpretation based on a single particular possibility of syntactic processing is considered to be the typical example which did not function well in this case.

In sentence 10 (13% correct), the ratio of parallel distributed processing, comparing with the whole group ratio (38%) was a little higher (43%), however, the percentage correct was the lowest. This means that although there were many possibilities to be considered in the initial parsing decision, it did not lead to the proper syntactic analysis, and/or interpretation carried out by many of the subjects participated in this research.

3.3 Statistical Analyses

(1) The tendency and correlation among the subjects' processing strategies

In the cognitive processes for syntactic processing and reanalysis, in Table 3, Pearson's correlation coefficients were obtained to investigate and elucidate the significant relationships between the scores of correct syntactic analysis, and/or translations (12 points) and the response scores of processing strategy (12 points in each item). The results are as follows:

Weak positive correlation was detected between the translation score, or the score for correct syntactic analysis, and parallel-distributed processing ($r=.266$), also between the translation score and the syntax-based processing strategy ($r=.434$). On the other hand, weak negative correlation was observed between the translation and the semantic processing strategy ($r=-.222$), also between the translation and unclear, or unidentified use of information ($r=-.332$).

Furthermore, weak positive correlation was detected between parallel-distributed processing and selective reanalysis ($r=.202$), and between parallel-distributed processing and the syntax-based processing strategy ($r=.289$).

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In addition, weak positive correlation was also seen between serial processing and forward reanalysis ($r=.202$). And weak positive correlation was also detected between backward reanalysis and delayed processing($r=.224$).

These results based on the correlation analysis indicated various aspects of significant research findings regarding the Japanese EFL learners' syntactic processing strategies as follows:

For example, the findings of positive correlation between the translation score, and the syntax-based processing strategy as well as between the translation score and the parallel-distributed processing can lead directly to the conclusion that the subjects' syntactic knowledge has a more crucial effect than semantic knowledge on the successful processing of the garden-path sentences and the other stimulus sentences which are difficult to parse. Furthermore, this conclusion is also well supported by the other findings of negative correlation between the translation scores and semantic processing strategy as well as unclear, or/and unidentified use of information.

In addition, the findings of positive correlation between the parallel-distributed processing and selective reanalysis as well as the parallel-distributed processing and the syntax-based processing strategy can also support a conclusion that the subjects' syntactic knowledge is more closely related to the successful processing than the semantic knowledge, and the other information.

The significant relations between these results and the differences in the subjects' proficiency levels will be further and thoroughly examined and elucidated in the next section,

Table 3. Pearson's correlation coefficient based on total score (12-point full marks) of correct translation and each processing, and/or interpretation process score.

	serial	parallel	immediate	delayed	for-word.	selective	backward	syntax	semantic	unfix
correct translation score	-0.154	.266 (**)	-0.068	0.143	0.084	0.115	-.192 (*)	.434 (**)	-.222 (**)	-.332 (**)
Serial processing		-.850 (**)	0.1	0.072	.202 (*)	-0.071	0.08	-.200 (*)	0.142	.220 (**)
Parallel processing			0.03	0.077	-0.089	.202(*)	-0.016	.289 (**)	-0.108	-.265 (**)
Immediate processing				-.839 (**)	0.056	.187(*)	-0.145	0.028	0.035	-0.013
Delayed processing					0.077	-0.041	.224 (**)	0.048	0.017	-0.04
Reanalysis: forward						-.686 (**)	-.401 (**)	-0.05	0.102	0.024
Reanalysis: selective							-0.123	0.157	-0.154	-0.033
Reanalysis: backward								-0.047	0.149	-0.047
Strategy: syntax-based									-.627 (**)	-.705 (**)
Strategy: semantic										-0.036

** 1% level of significance (two-tailed) * 5% level of significance (two-tailed)

(2) General tendency for sentence processing according to three different proficiency groups; the higher score group, the intermediate score group, and the lower score group

Taking the score of the correct syntactic analysis, and/or translation as the indicator of overall proficiency for sentence processing, the subjects were divided into three different proficiency levels of groups. The subjects who scored 8 and over out of 12 sentences were categorized as the high proficiency, or higher score group (High); the ones who scored 2 and less were low proficiency, or lower score group (Low); and the ones who scored between 3 and 7 were the intermediate group (Mid). Utilizing the three groups, the syntactic analysis, and/or interpretation process scores were compared. The result is shown in Table 4 and

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Figure 3.

It is observed that the lower the subject's proficiency level is, the greater the tendency for the serial processing to be adopted, in the order as follows: Low > Mid > High. In contrast, parallel-distributed processing tended to be adopted more frequently as the proficiency level increases: High > Mid > Low.

That is, since the lower score group did not utilize this parallel-distributed processing as frequently as the higher group, it can be claimed that the efficient and effective use of the parallel-distributed processing is closely related to the readers' sentence processing abilities. Furthermore, selective reanalysis had the similar tendency to parallel-distributed processing in that the lower group adopted this strategy remarkably less frequently than the higher score group. It is also previously shown by the correlation analysis that the tendency for selective analysis resembles that for parallel-distributed processing (see Table 3). Concerning the backward reanalysis, negative correlation is observed with minute differences between the groups. Although the corrections were statistically significant, the lower the proficiency level was, the more frequently this strategy was adopted; the lower group utilized this backward reanalysis more frequently than the higher group.

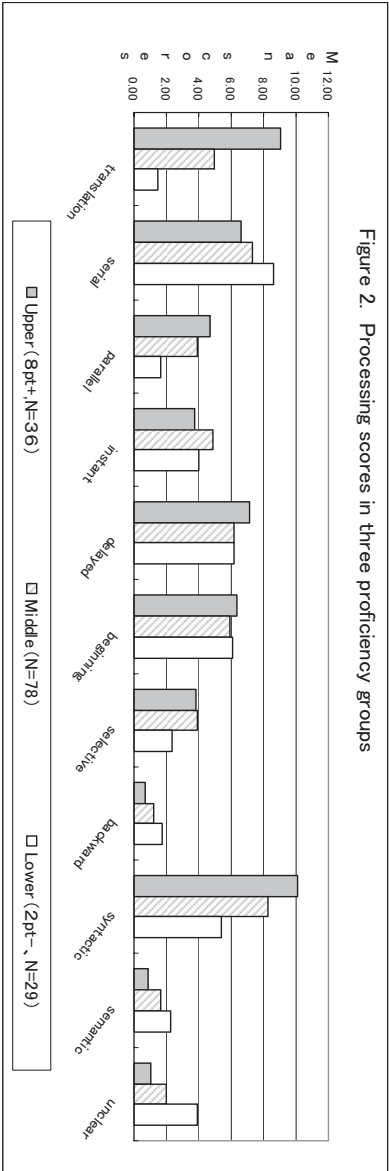
In the syntax-based processing strategy, it is evident that there is a major difference between the groups; the higher the proficiency level was, the more frequently the strategy was adopted.

Regarding the semantic processing strategy and the unidentified, and/or unclear use of strategy, the lower the proficiency was, the more the lower group adopted these semantic processing strategies, with the lowest group in particular using them noticeably more.

Table 4 Average scores in three different proficiency levels of groups

proficiency level		correct	route		timing		re-analysis			Strategy		
	translation	serial	parallel	immediate	delayed	forward	selective	back	syntax	semantic	unclear	
High (8+, N=36)	Ave.	9.08	6.64	4.67	3.72	7.17	6.33	3.83	0.67	10.08	0.83	1.03
	SD	1.42	3.35	3.53	3.41	3.45	3.93	3.97	1.35	1.92	1.65	1.11
Middle N=78	Ave.	5.00	7.35	3.94	4.85	6.17	5.90	3.91	1.23	8.23	1.62	2.04
	SD	1.36	3.40	3.33	3.56	3.47	3.39	2.94	2.16	3.29	2.22	2.26
Low (2+, N=29)	Ave.	1.52	8.59	1.66	3.97	6.17	6.07	2.38	1.72	5.41	2.24	3.93
	SD	0.69	3.49	2.22	3.98	4.38	4.17	3.42	3.07	3.98	3.23	3.64
Sum(N=143)	Ave.	5.32	7.42	3.66	4.38	6.42	6.04	3.58	1.19	8.13	1.55	2.17
	SD	2.86	3.45	3.34	3.62	3.66	3.68	3.35	2.23	3.52	2.37	2.58

Figure 2. Processing scores in three proficiency groups



4 Verification of Hypotheses

Hypothesis 1.1: In a single sentence level condition, the priority is, in principle, given to syntactic processing over semantic processing particularly in the initial parsing decision.

Based on the results shown in Table 2 and Fig. 2, the percentages of strategy use in the natural course of sentence processing were 69% for 'syntax', 13% for 'semantics', and 'unfixed' for 18%. The comparisons of average points showed statistically significant differences between 'syntax' and 'semantics' ($t=32.125, p<.001$) as well as between 'syntax' and 'unfixed' ($t=26.367, p<.001$). Therefore the hypothesis 1.1 was statistically supported.

Hypothesis 1.2: The subjects who put a priority on syntactic processing are inclined to process, and/or interpret the sentences which are difficult to parse, or the garden path sentences, more accurately and appropriately than the subjects who put a priority on semantic processing.

In addition to these differences, the Pearson's correlation coefficient between the correct translation score and each of the strategies, as shown in Table 3, displayed a significant positive relationship between correct translation and syntax ($r=.434, p<.01$). Since the correct syntactic analysis, or/and translation had the negatively correlated relationship with semantic information ($r=-.222, p<.01$), it can safely be said that relying on syntactic information is required as the principal processing strategy, or significant determinant for successful garden path sentence analysis. It can be said that the hypothesis 1.2 was supported. In addition to this, it was found that the negative relationship was stronger with unfixed, unclear strategy use ($r=-.332, p<.01$) than with semantic strategy use.

In order to verify the differences between the averages of syntax-based strategy for three different groups (higher score group =10.08, intermediate group =8.23, lower score group =5.41), test of analysis of variance (ANOVA) was performed. The difference among the three groups shown in Table 4 and Fig 3 were statistically significant ($F=17.535, p<.001$). In addition, the result of a multiple comparison by the Tukey method, which compares

the average value of each group individually, also yielded a significant difference ($p < .001$) between each group (high vs. low, high vs. middle, and middle vs. low.)

Hypothesis 2: The subjects who adopted parallel-distributed processing during syntactic processing have a higher possibility of reaching an accurate syntactic processing, and/or comprehension than the subjects who adopted serial processing.

The Pearson's correlation coefficients (Table 3) show us that when the number of correct answers of the Japanese translation and the number of responses indicating parallel processing were counted, a weak but statistically significant positive correlation was obtained ($r = .266$, $p < .001$).

In addition, in three different group comparison according to the translation, and/or syntactic analysis-based score, it was verified that the differences of the average of high vs. low and middle vs. low were both statistically significant ($F = 7.786$, $p < .001$ for three groups as a whole; the Tukey method comparison $p < .001$ for each pair). Based on these statistics, it can be judged that the correlation of resulting in the proper interpretation and parallel processing was supported.

Hypothesis 3: The readers who can return selectively to the target part in reanalysis processing are inclined to have a higher possibility of achieving an accurate syntactic analysis, and/or comprehension.

From the study based on correlation, a relationship of selective reanalysis with the correct Japanese translation was not found ($r = .115$, n.s.). The differences proved to be statistically significant between the averages of proficiency based groups ($F = 2.386$, $p = .096$), especially in the differences of high vs. low and mid vs. low. From these results, although correlation is not so strong, it can be said that the hypothesis is supported.

Hypothesis 4: A central embedded clause causes more complexity for syntactic processing.

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The target sentences for this hypothesis are No. 10 and No. 11. The percentage of correct answers was as low as 13% for No. 10, and 18% for No. 11, which was the lowest among the sentences. These results supported the hypothesis.

5 Need of sophistication in research method especially used for the present study

The following points need to be further elaborated and controlled for in later research.

- (1) Since in the case of adopting translation-based tasks to the subjects who are Japanese EFL learners, and use of the first language was required as one of the most influential determiners, the differences in Japanese proficiency levels might have significant effects on the research results. In experiment 1, the judgment of correct or incorrect syntactic analysis, and/or interpretation was primarily made by utilizing the statistical data obtained from translation-based tasks. However, in order to compensate for the above-stated problem, the approach having the subjects mark directly into the stimulus sentences in the tasks was also adopted.
- (2) Concerning the reflection of their syntactic analysis, and/or interpretation process, the significant differences in the subjects' metacognitive ability or working memory capacity may have influenced the amount of descriptive data and the quality of quantitative data collected from questionnaire style-based elicitation tasks.
- (3) Time provided for completion of the tasks was fairly adequate. So the cognitive burden of continuing to think about the complex and ambiguous syntactic structure of the target English sentences seems to have been severely challenged. As a methodological revision for mitigating this burden to some extent, the experiment can be carried out by using a selected number of the stimulus sentences in the data-collection tasks.

The above-mentioned issues should be thoroughly considered and revised, and the further experiments are essentially needed. Experiment 2 and 3 are conducted on the foundation of more plausible and valid research method.

Appendix 1: the data-elicitation task of the present study; experiment 1

課題：

- ①まず、次の各英文を和訳してください。
- ②和訳の際には、どんな文法事項や文の構造の知識を手がかりにしたのか、どんな点で誤訳をしそうだったかなど、和訳のプロセスも書いてみてください。
- ③書き方は例題を参考にして、和訳のほかに、主語や動詞や修飾・被修飾の関係の把握、関係詞節と主節の区別など、和訳を行う時に必要な事柄を、実際に英文に書き込みながら考えてみてください。また、和訳の時には、辞書は使用してかまいません。
- ④各英文について、①～③の作業が終わる毎に、(1)・(2)の質問に教えてください。

例題：(斜体[▼]字やカッコは書き込みの例)

The horse (raced past the barn) fell.

S

○←V

和訳： 全速力で納屋を通り過ぎた馬が倒れた。

和訳の手がかり： 最初の方にracedという動詞があるので、The horseが主語でracedがその動詞と考えたが、文の最後にfellという動詞の過去形が来ているので、その前のThe horse raced past the barn全体が主部だと考え直した。その結果、最初のracedは、形容詞の働きをしている過去分詞で、raced past the barnが主語のThe horseを修飾していると捉え直した。

質問 英文の意味が分からなかった時、どのように対処しましたか。それぞれ当てはまると思う記号に○をつけてください。

1 解釈の可能性についてはどのように考えましたか。

- ア. 1つの解釈の可能性だけを考えて、その解釈がうまくいかなかった時に、改めて別の解釈の可能性を考えた。
- イ. 最初から2つの解釈の可能性を考えながら読み進めた。

2-1 解釈を間違えたと判断した際には、どのように対処しましたか。

ア. 間違えたと判断した時点で、すぐに読み返した。

イ. 読み返さずに最後まで読み、読み終わった段階で判断した。

2-2 また、その場合には、どのような方法で読み返しましたか。

ア. 文頭まで戻って、もう一度読んだ。

イ. 間違いの原因と思われる部分まで戻って、もう一度読んだ。

ウ. 英文を、右から左へ逆戻りをしながら読み返した。

それでは、始めます。

1. Without her contributions failed to come in.

*contributions 「寄付」

和訳

和訳の手がかり

質問 英文の意味が分からなかった時、どのように対処しましたか。それぞれ当てはまると思う記号に○をつけてください。

1 解釈の可能性についてはどのように考えましたか。

ア. 1つの解釈の可能性だけを考えて、その解釈がうまくいかなかった時に、改めて別の解釈の可能性を考えた。

イ. 最初から2つの解釈の可能性を考えながら読み進めた。

2-1 解釈を間違えたと判断した際には、どのように対処しましたか。

ア. 間違えたと判断した時点で、すぐに読み返した。

イ. 読み返さずに最後まで読み、読み終わった段階で判断した。

2-2 また、その場合には、どのような方法で読み返しましたか。

ア. 文頭まで戻って、もう一度読んだ。

イ. 間違いの原因と思われる部分まで戻って、もう一度読んだ。

ウ. 英文を、右から左へ逆戻りをしながら読み返した。

Appendix 2: 12 different types of stimulus sentences used for the data-collection tasks of the present research

1. Without her contributions failed to come in. (θ 再解析、LC)

2. John knew the children at the day care center were noisy. (LC)

3. While the boy scratched the big and hairy dog yawned loudly. (LC)
4. This was only the beginning of the bad-mouthing robots would receive for the next couple of decades. (LC, θ 再解析)
5. An old man talked to by Mary came to see her. (LC)
6. The criminal confessed his sins harmed too many people. (LC)
7. As the woman edited the magazine amused all the reporters. (LC)
8. I recognized you and your family would be unhappy here. (LC)
9. The oxygen produced built up in the atmosphere. (LC)
10. I told the boy the dog bit Sue would help him. (LC, θ 再解析[中央埋込])
11. The cotton clothing is made of grows in Mississippi. (LC, θ 再解析[中央埋込])
12. The pitcher tossed the ball tossed the ball. (EC) %
- * 下線の文は実験2にも使用した文

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